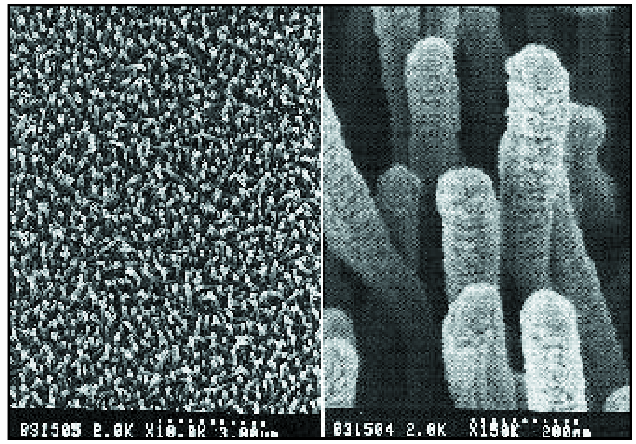
Advanced manufacturing techniques and new catalyst substrates reduce costs

O A A T   A C C O M P L I S H M E N T S

Low-Cost Membrane Electrode Assemblies

Challenge

The membrane electrode assembly (MEA) is the most costly component of the polymer electrolyte membrane (PEM) fuel cell system. To reduce the cost of the MEA, platinum content must be decreased (while maintaining or enhancing MEA performance) and continuous processes for fabricating MEAs in high volume must be developed.



SEM micrographs of Pt coated, nanostructure support whiskers at 10,000 x and 150,000 x.

Technology Description

3M Company has developed integrated pilot processes to manufacture high-performance MEAs with low platinum loading in high volume. A novel, five-layer MEA design employing a unique, proprietary nanostructured thin-film catalyst support system has been developed. Pilot plant, high-volume fabrication, employing vacuum coating of precious metal catalysts onto nanostructured substrate, has been successfully demonstrated. Single-cell MEAs were evaluated with various catalysts, membranes, and gas diffusion layers to determine optimal configurations and compositions. The nanostructure designs were scaled up to larger cross-sectional areas, and short stacks of six cells have been constructed and tested.

Accomplishments

- The novel 3M nanostructured MEA design concept has been extended to a six-cell stack. This demonstrates the viability of these MEAs to be scaled in area and manufactured by the continuous process methods and anode and cathode catalysts developed previously by 3M.
- Methods to screen the performance of new catalyst compositions and structures were developed and in-situ techniques for characterizing MEA properties were implemented. Optimal water management and operating conditions for the nanostructured MEAs were identified.
- Laboratory quantities (100-ft2 batches) of catalyzed electrode material, with low precious metal alloy loadings of 0.005 to 0.1 mg/cm2, were prepared. Experimental MEAs with a catalyst loading of 0.10 mg Pt/cm2 were fabricated and tested.

Benefits

- The development of nanostructured catalyst substrates allows optimized MEA performance with minimum precious metal content, resulting in reduced stack costs.
- The development of viable high-volume, low-cost manufacturing techniques for MEA components, coupled with automated MEA assembly and cell testing, significantly impacts time and cost in manufacturing fuel cell stacks.

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Future Activities

This project will continue to investigate anode and cathode catalysts that can be deployed in scalable manufacturing processes utilizing the unique nanostructured support structures. The results of this work will be used to support continued development of catalyst-coated membrane assemblies. Pilot-scale plant operations will improve on-line process control, production yields, quality, and MEA performance.

A 10-kW stack with optimized flow fields will be designed, constructed, and tested. Pilot plant work will pursue further reductions in precious metal loading, while maintaining or increasing power density in MEAs. Several full-scale MEAs, with greater than 500-cm^2 active area will be prepared for short stack testing. Cost analysis will be completed.

Partners in Success

- 3M Company
- Energy Partners